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**SCENARIO PROJECTING OF CHANGES IN PLANT WATER AVAILABILITY IN THE  
STEPPE CRIMEA IN THE 21ST CENTURY**

© 2024. E.M. Guseva, O.N. Nasonova, E.E. Kovaleva

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Simulations of the water balance components and indices of plant water availability were carried out for the Steppe Crimea for the period 1961-2100, using the SWAP land surface model and scenario projections of the dynamics of daily values of meteorological forcing data, obtained by global climate models with a half-degree spatial resolution. Climatic values of mean annual near-surface air temperature, annual precipitation, evapotranspiration, surface runoff, drainage, real and potential transpiration, plant water availability, efficiency of usage of soil water resource by ecosystems were calculated for the historical (1981-2010) and two projection (2031-2060 and 2071-2100) periods under different climate change scenarios: SSP1-2.6, SSP3-7.0, and SSP5-8.5. The analysis of changes in the listed characteristics in the 21<sup>st</sup> century on the territory of the Steppe Crimea was carried out.

*Key words:* water balance components, evapotranspiration, plant water availability, projecting, SSP-scenarios of climate change.

*Funding.* The research was carried out within the framework of topic No. 0126-2021-0001 (state registration No. 121040700170-9) "Development of a methodological base and digital technologies for decision-making to ensure water security in Crimea" (section Components of the water balance and characteristics of moisture availability of ecosystems in the territory of Steppe Crimea in the historical period) and topic No. FMWZ-2022-0001 "Studies of the processes of the hydrological cycle of the terresty and formation of water resources, geophysical processes in water objects and their basins, formation of extreme hydrological phenomena and dynamics of hydrological systems taking into account change of climatic conditions and anthropogenic factors" (all other sections of the article) The state assignment of the IVP of the Russian Academy of Sciences.

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**PROBLEMS OF ORGANIZATION OF IRRIGATED SOILS SALINIZATION  
MONITORING**

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The article discusses the problems of the organization of irrigated soils salinization monitoring in Russia and proposals for optimizing monitoring based on the integrated use of remote and ground-based information, based on their own research experience in the Volgograd oblast. The research method is a comparative analysis of existing approaches to monitoring saline soils in the Russian Federation and abroad. The concept of "saline soils" is defined in the article. It was designated in which soil layer it is necessary to take into account the presence of easily soluble salts to classify soils as saline. Also solonetz and solonetz soils are considered as saline. It is proposed to supplement the ground monitoring carried out by hydrogeological and meliorative parties that keep records of salinized and salinized-solonetz soils on irrigated lands by ground and analytical methods with annual monitoring (during the spring-summer period), which is based on remote information for a comprehensive and complete survey. This approach will make it possible to identify irrigated, rain-fed and fallow lands on the territory of irrigation systems by satellite imagery; to identify areas with secondary soil salinization on irrigated lands with a critical groundwater level, according to the state of vegetation, and take samples for analytical work on them, and to identify areas of salinized-solonetz soils on rain-fed lands and fields with a non-critical groundwater level also according to the state of vegetation. All this will make it possible to expand the database and characteristics of salinized and salinized-solonetz soils in addition to the information obtained by hydrogeological and melioration parties from permanent observation plots and to carry out better accounting. Such information is necessary to develop measures to stabilize and restore soil fertility, especially since salinized soils are a huge potential of the country's soil fund, which can currently and in the future be used in agricultural production.

*Keywords:* monitoring, salinized soils, salinized-solonetz soils, space information.

*Funding.* The research was carried out on the topic of state task No. 0439-2022-0009 "To study the transformation, evolution and degradation of the soil cover of agricultural landscapes at different structural levels, including intra-field heterogeneity using a combination of ground surveys and digital technologies."

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**METHODOLOGICAL PROBLEMS OF SALINITY EVALUATION IN ARID SOILS BY THE ELECTRICAL CONDUCTIVITY OF THE LIQUID PHASE**

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Express assessment of salinity by the electrical conductivity of the liquid phase of the soil is widely used throughout the world. However, the results of such an assessment strongly depend on the «soil-water» ratio, while the known salinity standards for electrical conductivity are proposed for the soil solution in the state of soil water saturation (total water capacity). Thus, a serious underestimation of the degree of salinity may occur when using water extracts (suspensions) with an obviously higher soil-to-water ratio compared to the state of total water capacity. In this regard, the purpose of the study was to compare the GOST methodology in Russia with a soil-water ratio of 1:5 and the classical Richards method with an assessment of the electrical conductivity of a soil solution in a water-saturated state on the example of arid soils with different genesis and dispersion in the Republic of Uzbekistan. In contrast to the well-known works on the empirical assessment of the influence of the soil-water ratio by the conductometric assessment of salinity, we applied the fundamental theory of dilution to justify the reduction of the results to the standard state of water saturation in order to use the international soil salinity classification. The results showed a satisfactory agreement between the experimental data and the theory of dilution in the range of electrical conductivity values up to 30-35 dS/m, that is, up to the gradation of a very strong degree of salinity according to the international classification. Deviations from the theory can be explained by the non-linearity of electrical conductivity depending on the concentration of electrolytes, immobilization of ions by the solid phase and fine pores, as well as a higher yield of electrolytes into solution at high dilution compared to the standard state of water saturation.

*Keywords:* arid soils, salinity, soil solutions, electrical conductivity, dilution, soil water capacity and porosity, soil bulk density, modeling.

*Funding.* The methodological part of the research, including problem setting, mathematical and statistical processing, data analysis and conclusions, was carried out with the support of the Russian Science Foundation (interdisciplinary project No. 23-64-10002). Field research and laboratory experiments were carried out within the framework of the theme "Food security and sustainable development of agriculture in the Eurasian region" of the Agricultural Center of Moscow State University (Decree of the Government of the Russian Federation No. 1736-r dated 06/26/2021).

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**HALOMORPHIC SOILS OF COASTAL DEPRESSIONS OF DRAINLESS PULSATING CHLORIDE LAKES DURING REGRESSIVE (ARID) CLIMATIC PHASE**

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Over the past half century, global warming has become one of the serious problems, accompanied by the following ecosystem reactions - climate aridization and subsequent desertification of landscapes. In Southeastern Trans-Baikal (Dauria) and the border areas of Mongolia and China, the problem is exacerbated by regionally occurring cyclical (approximately 30-years) humid (transgressive) and arid (regressive) climatic phases. There are more than 500 drainless saline and brackish lakes of various chemical composition and varying degrees of mineralization within these territories. Naturally, all ongoing climatic changes are clearly reflected in hydrology and chemical composition of these reservoirs and in the landscapes of lakeside depressions, including soil cover. Studies of the main types of soils of the lacustrine depression of the pulsating chloride Lake Babie have been performed within the regressive climatic phase. Soil morphology, texture, physical and chemical properties, composition and chemistry of salinity have been studied for the first time. These soils have been established to form a genetically related series of saline soils: chloride quasi-gley solonchaks – humus-quasi-gley saline – light-humus saline. It was revealed that solonchaks genesis is directly influenced by highly mineralized lake waters. Humus-quasi-gley saline soils, formed on supraquatic positions, are periodically affected by lake waters and actively - only in the humid climatic phase. Also, the results of the studies indicated that chloride-soda and soda-chloride salinization was noted in the lower horizons of humus-quasi-gley and light-humus soils. Data obtained will be necessary for monitoring of saline soils and ecosystems of lakeside depressions of cyclically pulsating highly mineralized drainless basins within the transboundary territories of Trans-Baikal (Russia), Mongolia and China under global and regional climate changes.

*Keywords:* arid climatic phase, Southeastern Trans-Baikal, drainless lakes, halomorphic soils, soil properties, salt composition, chemistry of salinity.

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**LIPID FRACTION OF ORGANIC MATTER IN CRYOARID SOILS**

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For the first time, the characteristics of the lipid fraction of the organic matter of dry steppe and permafrost soils of Western Transbaikalia are given. <sup>13</sup>C NMR spectra of lipid preparations were recorded from chestnut soils of the Selenga middle mountains and quasi-gley chernozems in the south of the Vitim plateau. The spectra were analyzed: the signals of ethoxy groups, phenol derivatives, and alkene fragments were assigned, the ranges of chemical shifts characteristic of certain types of carbon nuclei were indicated, and the content of various types of structural elements in the studied samples was compared. The relationship between lipid components and soil hydromorphism in quasigley chernozems has been determined. Presumably, an increase in the degree of hydromorphism will lead to an increase in the proportion of unsaturated components.

*Keywords:* lipid fraction of organic matter, <sup>13</sup>C NMR spectroscopy, carbon, chestnut soils, quasi-gley chernozem, Western Transbaikalia, Selenga middle mountains, south of the Vitim Plateau.

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**ESTIMATION OF THE DYNAMICS OF PLANT COMMUNITIES IN THE EASTERN PART OF THE VOLGA RIVER DELTA (1980-2023)**

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The results of observations of the vegetation dynamics on stationary transects in the eastern part of the Volga River delta are presented. 498 sample plots 2 x 2 m were located on ecotopes mainly under the influence of floods. Geobotanical relevés of sample plots made in 1980, 2011, and 2013 were compared. Five groups of plant communities were identified using cluster analysis. DCA ordination and Ramensky's indicator values were used to establish the directions of changes in vegetation. It was found that most of the changes in vegetation on the transects occurred between 1980 and 2011. The place of grass marsh-meadows was taken by reed and cattail thickets. The areas of halophytic phytocenoses sharply decreased and were replaced by these thickets and meadow plant communities dominated by *Elymus repens* (L.) Gould. According to the authors, there are two main reasons for these phenomena. The first is the increase in water flow of the Volga River, which occurred after 1980. The second is the cessation of hay harvesting in a significant part of the meadows and wetlands. Noticeable changes in vegetation between 2011 and 2023 occurred only on the lower parts of the slopes of the Baer hillocks. In the last year, there has been an increase in the number of sample plots with plant communities of mid-steppe moisture, which descended down the slopes of the Baer hillocks.

**Keywords:** division gate, regulation of water flow, soil desalinization, xerophytization of vegetation, forage lands.

**Funding.** The research was carried out under support of the Russian Science Foundation, project No. 23-24-00008 "Assessment of the dynamics of flora and vegetation of the Volga River delta under the influence of anthropogenic and natural factors."

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**BIODIVERSITY OF THE EXPOSITIONAL FOREST-STEPPE OF SIBERIAN  
MOUNTAIN BIOMES**

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The forest-steppe is considered as an integral geographical and ecological-phytocenotic zonal phenomenon of Northern Eurasia, which has its own characteristic features. A peculiar high-altitude belt of the expositional forest-steppe is formed in the mountains of Siberia and occupies a certain place in the altitude-belt spectra of the mountains. The structure of the oroboreal forest-steppe is considered on the basis of an ecosystem concept and an ecological and geographical approach to data interpretation. The expositional forest-steppe is a complex combination of plant communities of forests and steppes, which occupy contrasting ecotopes within the same altitude stage, forming a single indigenous altitude-climatic ecosystem, where its components closely interact with each other and with the surrounding natural conditions. The cenotic and biotic diversity of the forest-steppe is provided by bioclimatic conditions that determine the hydrothermal distribution areas of mountain formations and the composition of their climatic variations. The characteristic of the expositional forest-steppe combinations of 7 regional orobiomes of Siberia provides comparative information about the geography of the mountain forest-steppe, the combination of forest and steppe communities, their composition and bioclimatic conditions of development.

*Keywords:* expositional forest-steppe, mountain biome, orobiome, type of belt, altitude-belt spectrum, geography of biodiversity.

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**GEOGRAPHICAL CONDITIONS AND DISTRIBUTION FACTORS OF POISONOUS  
PLANTS IN KAZAKHSTAN**

© 2024. T.V. Dikareva, M.S. Soldatov

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The purpose of the work is an ecological and geographical analysis of the distribution of poisonous plants in the floristic regions of Kazakhstan and the influence of arid conditions on it. As a result of the study, 51 of the most toxic species of vascular plants belonging to 34 families were identified on the territory of Kazakhstan. The cartographic analysis showed that the smallest number of species of poisonous plants is confined to the flat floristic regions of the northern deserts, and the largest number of such species grows in the mountain steppe regions. The maximum number of poisonous plant species was found in Karatau and Western Tien Shan, as well as in Tarbagatai and Altai. The smallest number is in Mangyshlak, Northern and Southern Ustyurt and Buzachi.

*Keywords:* poisonous plants, floristic regions, aridity, cartographic analysis, toxic effects.

*Funding.* The research was carried out within the framework of the topic of the state task No. CITIS 121051100137-4 of the Lomonosov Moscow State University "Spatial and temporal organization of ecosystems in the context of environmental changes", as well as the Development Program of the Interdisciplinary Scientific and Educational School of Moscow State University "The Future of the planet and global environmental changes".

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**CURRENT STATUS OF THE KULAN (*EQUUS HEMIONUS* PALLAS, 1775)  
POPULATIONS IN CENTRAL ASIA COUNTRIES**

© 2024. A.A. Lushchekina, T.Yu. Karimova, V.M. Neronov

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Even in the recent past kulans (*Equus hemionus* Pallas, 1775) lived in Eurasian steppes and deserts – from the eastern shores of the Mediterranean Sea to China. On the territory of Russia, the last kulan was met in 1926 in the area of the Torey Lakes, and in recent years the question has been raised about the possibility of reintroduction of these animals in the Daurky Reserve. This review presents information about the current status of the populations of the Mongolian and Turkmen kulan living in the Central Asian countries (in Kazakhstan, Uzbekistan, Turkmenistan, Mongolia and China) bordering Russia.

Currently, in the countries close to Russia, autochthonous populations of kulan are preserved in the southern regions of Mongolia and adjacent parts of northern China, inhabited by the Mongolian kulan (*E. h. hemionus* Pallas, 1775). The largest population lives in Mongolia, where experts currently estimate that there are approximately 70,000 individuals (or 83% of the world population of the species). Almost half of Mongolian kulan range (42%) is in national-level protected areas, but the size of existing protected areas, where kulans spend only about 23% of their time, is not so large that animals are fully protected by them. The possibility of expansion of the protected area network to 30% of the country's territory by 2030 allows us to believe that the kulan, like other migratory species of ungulate arid zone, has good perspectives.

About 80% (or just over 3,000 individuals) of kulan population in China currently inhabits the Kalamaili National Nature Reserve in Xinjiang, making this protected area crucial for the conservation of the species.

In the 30s of the last century, kulans disappeared from Kazakhstan and Uzbekistan. In Turkmenistan, the indigenous population of the Turkmen kulan (*E. h. kulan* Groves and Mazák, 1967) inhabited the Badkhyz Reserve, but was most likely lost in recent years. A successful program for the reintroduction of kulans, launched back in the 1980s, made it possible to preserve these animals (mainly in nature protected areas) within its historical range. In 2023, just over 30 kulan individuals lived in Turkmenistan on the territory of two sites with a total area of 800 km<sup>2</sup>: in the valley of the Tersakan River to the west of the borders of the Sunt-Khasardag State Natural Reserve and on the territory of the Kaplankyr State Natural Reserve in the border zone. According to experts, it is very likely that in the near future the species will completely disappear in the country, since none of these groups can be considered viable.

The number of kulans living on the territory of the Saigachiy and Sudoehye reserves, as well as the South Ustyurt National Natural Park in Uzbekistan, is currently estimated at 170 heads. Kulans are also actively breeding in the Jeiran eco-center.

The reintroduction of kulans in Kazakhstan was successful – in 6 protected areas in 2022-2023 there were about 4400 kulans, and these work continues.

From the presented review on the modern state of the kulan, which lives in the territory of the Central Asian countries, it can be resumed that the restoration and protection of the species throughout its range was and is paid great attention. This and providing animals with suitable living conditions, including the organization of a network of watering sites, elimination of obstacles in the form of linear structures creating obstacles for the migration of animals, regulation of the number of

livestock, formation of a network of protected areas of different levels, inclusion of the species in the Red Books and adoption of legislative acts on responsibility for its illegal take off, establishment of centers for breeding and keeping kulans for their subsequent reintroduction, conducting joint long-term and systematic studies, including monitoring of populations.

*Keywords:* kulan, Central Asia, range, number, conservation of species.

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**CONSERVATION OF RODENTS IN THE FOREST-STEPPE OF EUROPEAN RUSSIA**

© 2024. I.V. Zhigarev, V.Yu. Rumiantsev

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Forest steppe is an ecotone biome, which is seriously changed by men. Rodents are important part in the forest steppe ecosystems. These mammals can be characterized by high special diversity and occupation of different ecological niche. Rodents significantly effect on agriculture, medicine and health, and other parts of human life. Meanwhile, human affect on rodents has many faces too. Life of rodents is most disturbed by human influence within seriously reconstructed landscapes. Forest steppe of European Russia is one of these landscapes. Modern condition and effectivity of rodent conservation in this land needs analysis. In this paper, we paid attention to federal and regional Red Books. Distribution of federal level reserves and rodent abundance in these reserves were estimated too. We collected data of rodent species preservation and status of preservation from regional Red Books. Reserves are briefly characterized. Distribution of every rodent species in these reserves analyzed. We produced the map of reserves and the table of rodent species abundance. The forest-steppe of European Russia consist of three biomes – the Dnieper-Volga, Zavolzhsky, Crimean-Caucasian, in which 45 species of rodents are recorded. 35 species are found in Dnieper-Volga biome, 27 – in Zavolzhsky biome, 27 – in Caucasian part of Crimean-Caucasian biome, 19 – in Crimean part of Crimean-Caucasian biome. These biomes are located within territory by 21 regions of the Russian Federation. 14 federal-level protected areas are situated there – 7 nature reserves, 4 nature reserves and 3 national parks. Nine of them have data on the rodents species composition. 24 species of rodents living under protection at least in one region. Number of protected species vary from 2 in Bashkortostan and Tula oblast to 13 in Chuvashia. One species (spotted ground squirrel) are protected on federal level. 33 species of rodents are recorded in federal level reserves. Number of rodent species in reserves vary from 11 (Voroninsky zapovednik) to 26 (Belogorye zapovednik). *Keywords:* forest steppe, biomes, rodents, special composition, special abundance, Red Books, reserves, status of conservation.

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**FLUORESCENCE OF CHLOROPHYLL A OF TARÁXACUM OFFICINÁLE WIGG. AS INDICATORS OF THE PHYSIOLOGICAL STATE IN THE CONDITIONS OF MOUNTAIN DAGESTAN**

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Studies of the efficiency of photosynthesis, the qualitative and quantitative composition of free amino acids *Taraxacum officinale* Wigg., growing at different heights, are presented in the article. The conducted comprehensive studies have shown the high adaptability of dandelion officinalis to abiotic stress factors. It is shown that, with an increase in altitudinal zonality, the efficiency of solar energy conversion ( $Y(II)$ ) decreases due to photoinhibition ( $\beta$  and  $I_b$ ). An increase in the relative rate of non-cyclic electron transport along the electron transport chain allows high-altitude (alpine) plants to maintain photochemistry at the required level, thus ensuring bioproductivity and energy balance. In the roots of *Taraxacum officinale* Wigg. 16 free amino acids have been identified, 6 of which are essential. The amount of free amino acids varies according to the zoning gradient: in high-mountain samples, the content of  $\alpha$ -alanine, arginine, methionine, serine, cysteine, threonine, and proline increases. Changes in biophysical reactions and primary metabolites of the studied plants in terms of altitudinal zonality are a consequence of the impact of abiotic factors and are adaptive in nature.

*Keywords:* abiotic factors, altitude gradient, fluorescence, PAM, photosynthesis.

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NATURAL CONDITIONALITY OF ANCIENT FARMING TERRITORIES NORTHWEST  
AND CENTRAL MONGOLIA

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The article presents materials that are a continuation of the research of ancient agriculture in Mongolia. Traces of numerous ancient agro-irrigation landscapes and settlements associated with them were found in Northwestern Mongolia (Ubsunur basin, western spurs of the Hangai). The geological position of this territory, mountain-forming processes, neotectonic shifts, have created here, along the young uplifted ridges, numerous subaerial deltas favorable for the development of sayan agriculture, attributed to the early stage of ancient irrigation. Initially, the collapsed channels of temporary flows of subaerial deltas have grown into very extensive irrigated areas. In addition to traditionally irrigated landscapes (subaerial deltas, deluvial-proluvial slopes, floodplains), allotments tend to peat bogs, detached soils formed in the basin of the lake. Ubsu-Nur, as well as peat bogs formed as a result of the spring-loading of the Nariin-Gol river during the rise of the Agardag ridge. The territory of Mongolia belongs to the area of manifestation of young basaltoid magmatism, the concentration of ancient fields in the immediate vicinity of modern volcanoes (Khorgo, Tesiingol area) involves the use of fertile volcanic ash, natural heat, in the economic practices of the population. Presence in the upper reaches of the river. Tes (western spurs of the Hangai) steles with runic script dating from the second half of the VIII – beginning of the IX century, makes it possible to attribute one of the agricultural stages of Mongolia to the Uighur time.

*Keywords:* Mongolia, Ubsunur basin, decoding of satellite images, valley of the Tes-Khem River, Nariin-Gol River, Agar Dag ridge, Bulnai ridge, neotectonics, peat bogs, subaerial deltas, ancient agriculture, settlement sites, modern volcanism, Tesinskaya stele.

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**FUNCTIONAL ROLE OF THE ELEMENTS OF THE LAND CADASTRE IN THE  
CONDITIONS OF ARID SOIL FORMATION**

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The Earth's surface is a complex of numerous and diverse objects, where the leading role belongs to the soil cover and its components, which are in dynamic development. Rational, diversified use of soils in the national economy and the correct placement of the productive forces of society are associated with the development of a sound ecological and biospheric concept of the development of the structure and composition of the elements of the land cadastre, a characteristic feature of which is their dynamics and interaction with the processes of anthropogenic soil formation. Currently, studies of soil cover have been widely developed as an important element of the land cadastre and the practical basis for the development of land relations.

The variety of objects located on the Earth's surface and their functional role are represented by categories of natural and anthropogenic formations that are producers and consumers of biological products.

Based on the productivity indicators of the selected categories within the framework of independent entities that are in dynamic development, an ecological balance has been established (Vinogradov, 1998). Over time, in the process of development, they can move from one functional category to another. The soil cover and its functioning area are objects of means of production and categories that perform general biospheric functions. These functions are defined as a source of biological products and are studied within the framework of various scientific directions: territorial planning of the subjects of the Russian Federation, soil bonification, cadastral registration of land and environmental assessment as national wealth and the basis of human production activity. In modern conditions, the soil cover is characterized by a tendency to intensify the use and decrease the functioning and productive areas.

*Keywords:* biospheric functions of soils, composition of soil cover, elements of the land cadastre, technosphere, soil salinization, geological objects, land surface, cadastral accounting.

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**THEORETICAL SUBSTANTIATION OF THE TECHNOLOGY OF AGROFORESTRY  
DEVELOPMENT OF AGRICULTURAL LANDS TO PROTECT AGAINST  
DEGRADATION AND DESERTIFICATION**

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The problem of protecting agricultural landscapes from degradation and desertification must be solved with a systematic and adaptive landscape approach to agricultural activities. Therefore, it is necessary to radically change the approach to modern agriculture. The main task should be to prevent degradation and desertification of agricultural landscapes. The methodological basis of our research and generalizations was the system of methods used in agroforestry and related sciences. When planning, conducting experiments and analyzing the results, we used statistical, genetic and elements of systematic approaches. Physical and mathematical modeling were used in the research. An important stage of the adaptive landscape system of agriculture is the agroforestry arrangement of the land use territory. Its technological process includes: calculation of runoff and flushing of soil and distances between forest belts; classification of lands according to the degree of soil erosion and the nature of their use; organization of the territory; determination of parameters and structure of runoff-regulating forest belts; creation of a system of drainage-regulating forest belts in the catchment area of 2-3 rows of trees and a number of low-growing shrubs, With the help of the developed technology of anti-erosion arrangement of catchments on land use, the placement of agricultural crops and forest strips on slopes is optimized, ensuring flow regulation, erosion-safe agricultural activities and increasing yields. Runoff-regulating forest belts and other protective plantings play an important role in the system of agroforestry measures. And in combination with other anti-erosion measures, forest strips play an important role in the formation of the ecological agroforestry framework of the territory and sustainable agroecosystems.

*Keywords:* soil erosion, , runoff factors, territory organization, land classification, agroforestry, catchment area, anti-erosion measures system.

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**ECOLOGICAL AND ECONOMIC ASSESSMENT OF SOIL DEGRADATION OF  
AGRICULTURAL LAND IN VOLGOGRAD REGION**

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The objective of this study was to estimate the damage done to agricultural lands as a result of soil degradation processes in the Volgograd region, Kalach-on-Don. To assess degradation level samples were collected in summer 2019 in the studied area and compared to soil property standards of Endosalic Kastanozems of Volgograd region. The valuation of soil ecosystem services was calculated based on «Методика определения размеров ущерба от деградации почв и земель» (1994), methodological framework was adapted and adjusted to modern conditions and regional specifics. The results showed that soils of the region are exposed to soil degradation. The prevalent process that leads to soil degradation is alkalization, which includes an increased proportion of exchanged sodium of cation exchange capacity.

Soil alkalization is caused by the irrigated water of the Karpovsk reservoir, which has been iridized for several decades. The most significant damage, 147,425,000 rubles, or 54,541 rubles/ha, was showed for 52% of the studied agricultural lands. The long period of restoration (reclamation), which lasts four years, also contributes to the alkalization process. The increase of soil density, changes in acidity and decrease of humus, potassium exchange, and mobile phosphorus compared to the standard for the agricultural were assessed as less significant (2nd degree of degradation), which shows sustainable land management of the region. Consequently, the contribution of these degradation indicators to the total damage is significantly low.

*Keywords:* damage assessment, soil degradation, alkalization, soil exhaustion, endosalic kastanozems, kastanozems sodic, arid ecosystems, ecological and economic assessment.

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**BIODIVERSITY AND YIELDING CAPACITY OF PLANT COMMUNITIES ON COAL  
HEAPS IN THE CENTRAL RUSSIAN UPLAND (TULA REGION)**

© 2024. S.A. Lednev, A.V. Sharapova, I.N. Semenov, P.P. Krechetov, T.V. Koroleva  
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Coal heaps of the Moscow brown coal basin represent the long-term experiment of the self-revegetation of the acid sulfate substrate by grasses and trees. The work investigated the biodiversity of vascular plants and the yielding capacity of plant communities formed on coal heaps in the Tula region and described at 32 sites of 10 × 10 m. It was founded that plant communities at the toeslope talus of the heaps have both lower plant diversity and an above-ground phytomass than grassland communities at reference sites. At the same time, the same parameters of the artificial plant communities formed during the reclamation of heaps exceed ones of the grasslands located in reference sites outside the acid mine drainage zones of the coal heaps.

*Keywords:* grasslands, aboveground phytomass, species richness, coal mining, recultivation, self-organized vegetation, Moscow lignite basin.

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